GIIF
GREEN INNOVATION AND INVESTMENT FORUM
Feb. 2015 – Award for ‚*Best Business Idea*‘ category ‚*Advanced stage*‘

STORASOL
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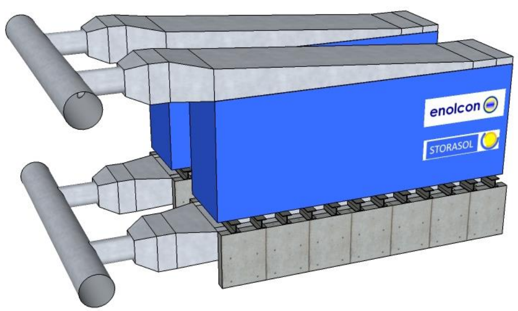
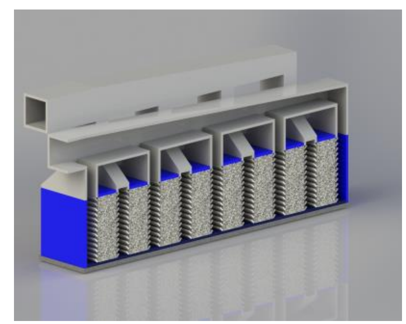
STORASOL – HTTES

Example Project

Calculation of Payback Period in a Brick Factory in Germany

‘Technology for the future and today’





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AGENDA

1. Brick Factory – Process Data Basis
2. High-Temperature-Thermal-Energy-Storage-System
3. Costs and Profitability

1. Brick Factory – Process Data Basis

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Process:

In the considered brick factory **bricks are dried and burned at different time intervals**. Hence the exhaust heat of the burner at temperatures of approx. 350°C is emitted into the surrounding environment. In order to increase the energy efficiency the high temperature waste heat of the burner is stored in a STORASOL High-Temperature-Storage-System and can then be used with time-shift in the dryer.

Note: Brick manufacturing systems are deviating with operation, operation parameters, air cleaning and flue gas cleaning, so in another production place the HTTES-might be implemented in a different way.

Temperatures:

The STORASOL High-Temperature-Energy-Storage will use excess heat at temperatures from 350 °C ➔ 200 °C.

Charging and Discharging Period:

Charging at 350 °C: 1 hour, Discharging: 1 hour.

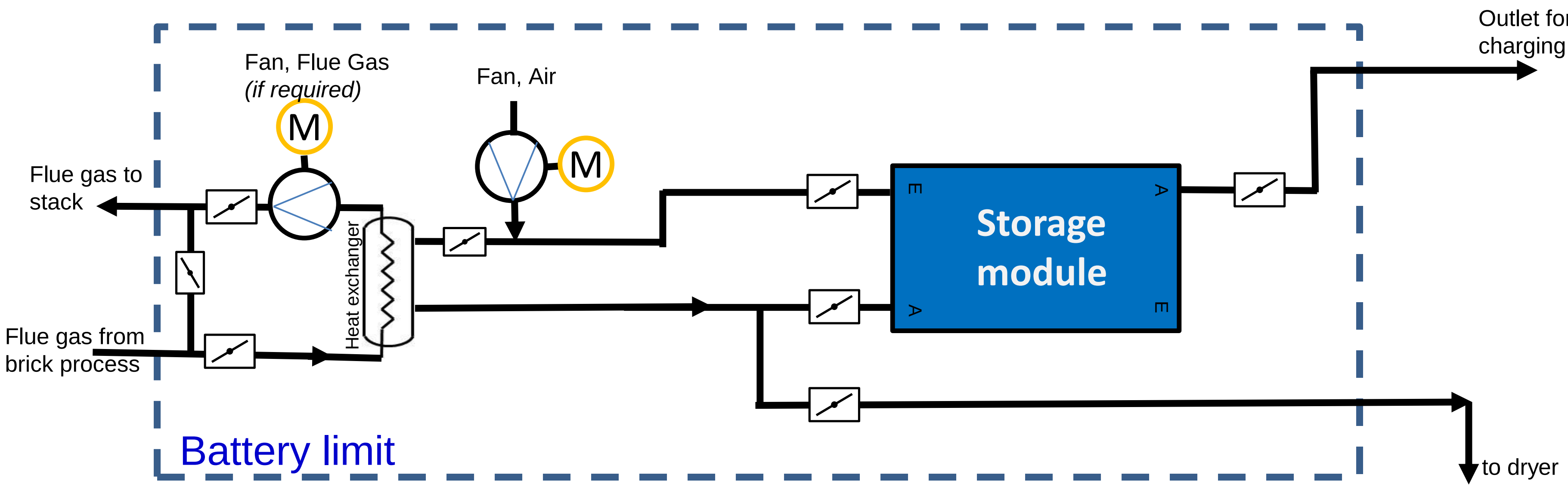
Flue gas volume flow rate: 8.000 - 10.000 Nm^3/h

Heat transfer media:

Charging of whole HTTES-**system** with heat from flue Gas. Storage module charging and discharging with ambient air. *Note: In the integrated concept (slide 5) flue gas is used for charging and discharging of the storage module.*

Basic Concept with 1 storage module and a heat a heat exchanger:

Using a heat exchanger, the energy storage system can be **decoupled from the flue gas system**. The heat exchanger can further expands the operating possibilities not considered in the following economical assumptions.



The expected costs for the storage system within the battery limits is approx. 260.000 €

2. High-Temperature-Thermal-Energy-Storage-System

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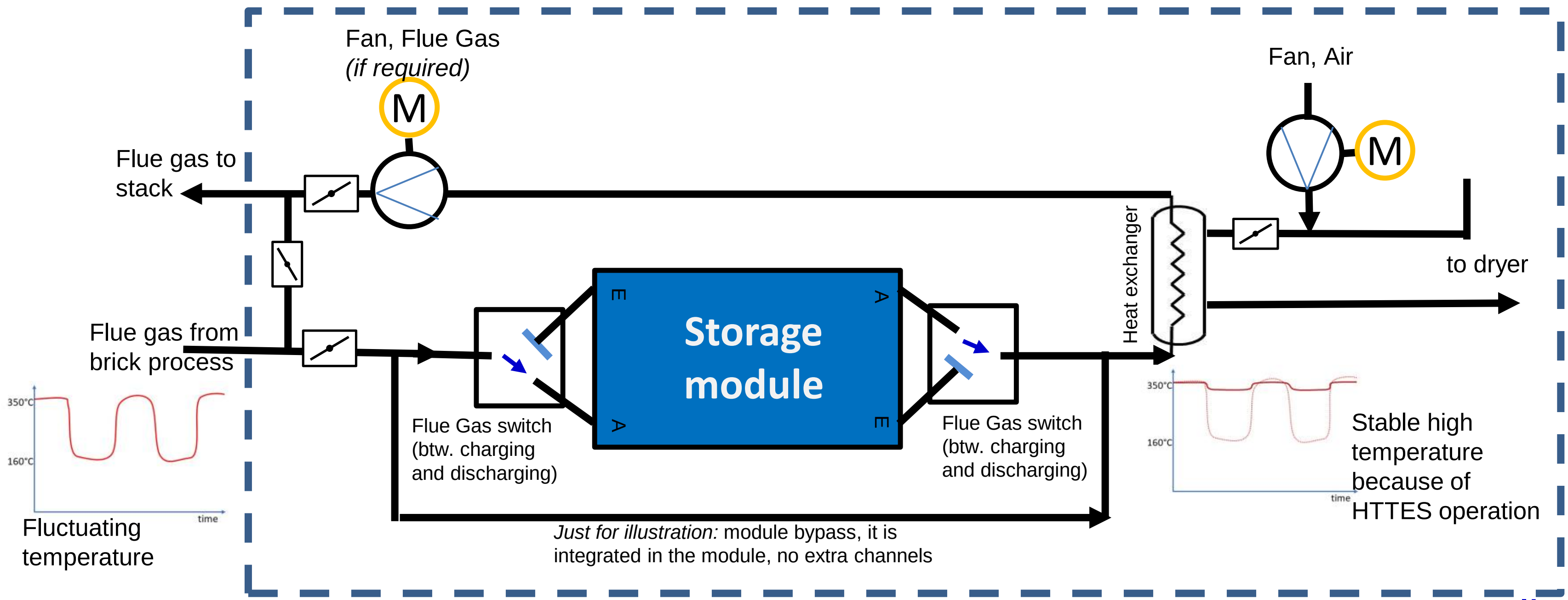
Integrated Concept with 1 storage module and a heat a heat exchanger:

In this concept the storage module is **integrated into the flue gas system** of the brick manufacturer. This concept is working **only with a STORASOL-HTTES**, because only the STORASOL-HTTES-modules have a very slim/short Thermocline of a few centimetres and can be directly integrated into the flue gas flow. The innovative design with the flue gas switches is not requiring a change of the direction of the flue gas main flow.
A heat exchanger is required to transfer the heat to air, the hot air is then used on the dryer.
The integrated concept has several advantages, but also some limitations. Which concept fits better must be analysed case by case.



Battery limit

The expected costs for the storage system within the battery limits for this integrated system is approx. 250 – 275.000 €.

3. Costs and Profitability

Profitability frame/base conditions:

In a cyclic mode with 1 hour charging and 1 hour discharging the following natural gas savings are achieved:

Energy savings per one cycle:	approx. 600 kWh_{th} (0,60 MWh_{th}) (Note: In integrated system approx.>0,7 MWh_{th})
Achievable cycles per day:	11 per day
Total energy savings per day:	11 x 0,60 MWh_{th} = 6,6 MWh_{th} per day
The annual operating period is:	330 days (approx. 11 months).
Saved natural gas quantity in total:	330 days x 6,6 MWh_{th} = approx. **2,180** MWh_{th} per year.
Assumption for natural gas price (HHV):	46 €/MWh_{th}
The **operating costs** for electricity:	approx. **6 kW_{el} per h** at costs of **160 € / MWh_{el} =**
	0,006 MW_{el} x 160 €/MWh_{el} x 8030 h/a **= 7709 €/a**
maintenance costs estimation:	approx. **1,0 % of Capex** costs (260.000 €) of system per year = **2.600 €/a**

3. Costs and Profitability

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Profitability Savings per year:

Cost item	Cost savings	expenditures
Saved natural gas	100.280 €/a	
Electrical own consumption		7.709 €/a
Maintenance costs		2.600 €/a
Total	**89.971 €/a (approx. 90.000 €/a)**	

Not considered are further possible advantages, some examples:

- ✓ The HTTES-system can allow more flexibility in the oven-temperature since the higher temperatures will be reduced by the HTTES-system, before they move to the stack. The heat is not lost, but recovered.
- ✓ Drying process might be optimized.
- ✓ CO_2-reductions due to lower natural gas consumption are not considered.

3. Costs and Profitability

Profitability :

Without any grants:	
Capex Costs storage system approx.:	**260.000,- €**
Annual savings approx.:	**90.000,- €**
Payback period approx.:	**2,9 years**

Return on invested capital (ROIC):

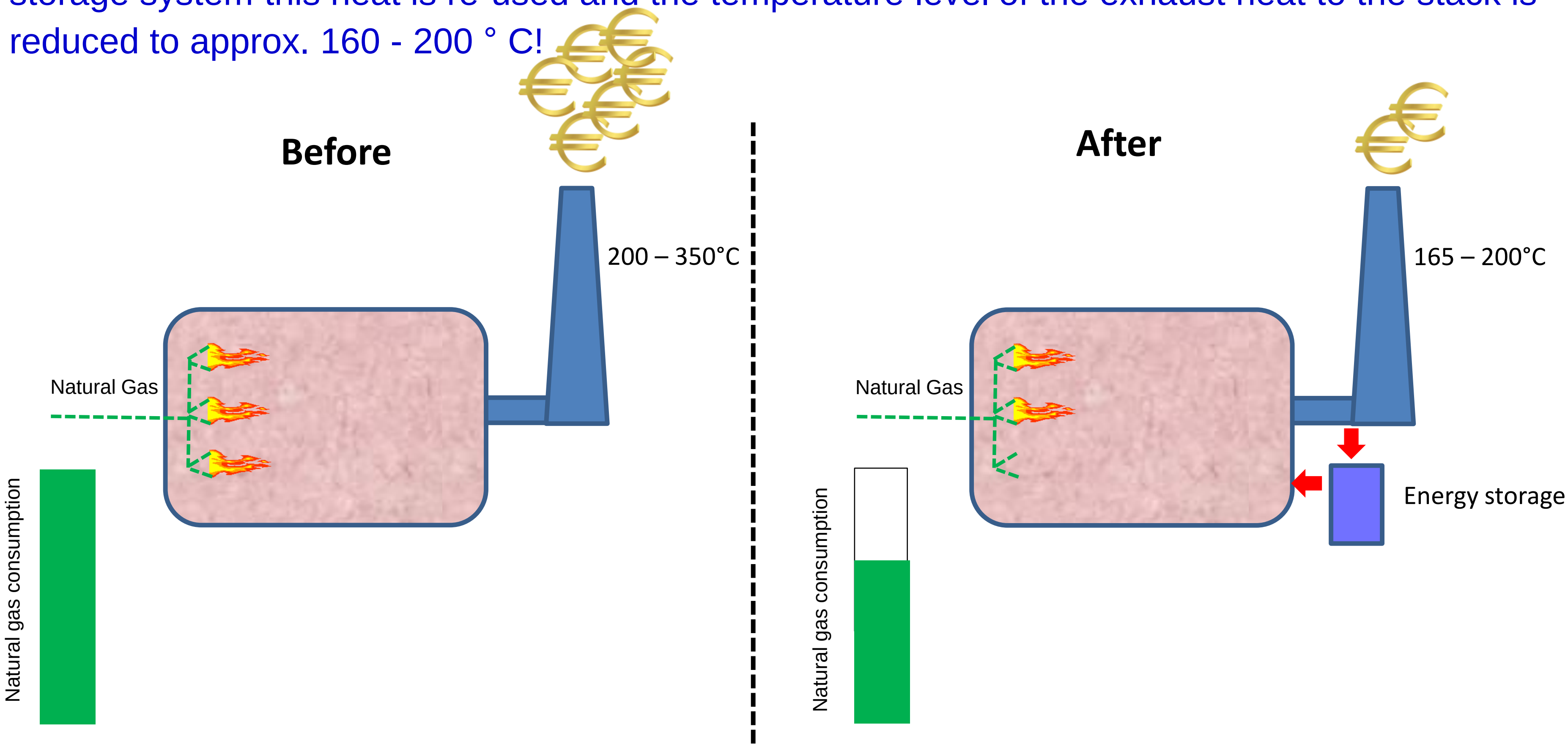
The HTTES-system can be operated for a period of more than 20 years. Since the payback period is normally approx. 2,5 – 5 years, the **ROIC** is very high for time periods of more than 10 years!

Example: In **ten (10)** years the **savings are approx. 900.000,- €**, the CAPEX was only 260.000,- € and the O&M-costs in total within 10 years have been approx. 103.000,- € *[10 x (7.709 € + 2.600 €)]*.

These are example figures which are derived from German brick manufacturing cases. Other cases might differ into both directions, it depends for example on the allowable temperature difference, the number of charging/discharging cycles, gas costs, electricity costs etc..

Basically, the **energy efficiency of the entire brick factory** is **significantly improved** by such a measure.

This can be seen in the fact that before the installation of the STORASOL High-Temperature-Energy-Storage-System **heat is lost** at a temperature level of 200 - 350 ° C. With the installation of the storage system this heat is re-used and the temperature level of the exhaust heat to the stack is reduced to approx. 160 - 200 ° C!



Thank you for your interest!

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